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With the run-up to the Nuclear Nonproliferation Treaty (NPT) Review Conference in May of 2010, major states have focused as never before on reducing existing US and Russian nuclear weapons stockpiles, reversing Pyongyang's nuclear buildup, and stopping Iran's nuclear weapons-related activities. The hope is that each of these efforts will be mutually reinforcing and lead to additional nuclear weapons reduction agreements between not only the United States and Russia, but the world's other nuclear weapons states. Finally, it is hoped that progress in reducing existing nuclear weapons will persuade the world's nonnuclear weapons states to do more to stay clear of dangerous civilian nuclear fuel-making activities and to open their civilian nuclear facilities to more intrusive international inspections.

This set of nuclear hopes, however, is unlikely to be fully realized. Barring regime change in either North Korea or Iran, neither Pyongyang's renunciation of its nuclear arsenal nor Iran's cessation of nuclear weapons-related activities is all that probable. As for further reductions in existing nuclear arsenals, there may be some strategic weapons reductions (perhaps to as low as 1,000 to 500 warheads) after the United States and Russia agree to the current follow-on to the Strategic Arms Reduction Treaty (START), but further agreements that might capture Russia's much larger number of tactical nuclear weapons are unlikely to come easily or quickly. Russia sees its conventional military capabilities falling further and further behind those of NATO and China. As a result, Moscow is more likely to increase its security reliance on its thousands of tactical nuclear weapons than it is to eliminate or reduce them. Meanwhile, the odds of China, India, Pakistan, North Korea, and Israel agreeing to nuclear warhead reductions seem even more remote.

Assuming that current nuclear trends continue, then the next two decades will test international security as it has never have been tested before. Before 2020, the United Kingdom will find its nuclear forces eclipsed not only by those of Pakistan, but of Israel and of India. Soon thereafter, France will share the same fate. China, which already has enough separated plutonium and highly enriched uranium to triple its current stockpile of roughly 300 nuclear warheads, will likely expand its nuclear arsenal, too. Meanwhile, Japan will have ready access to thousands of bombs' worth of separated plutonium. US and Russian nuclear

weapons-usable material stocks – still large enough to be converted back into many tens of thousands of weapons – will decline only marginally, whereas similar nuclear stores in Japan and other nuclear weapons states could easily double.[1] Compounding these developments, even more nuclear weapons-ready states are likely to emerge: As of 2010, at least 25 states had announced their desire to build large reactors – historically, bomb starter kits – before 2030.

None of this will bolster the cause of nuclear weapons abolition. Compounding these worrisome trends is the growing popularity of "peaceful" nuclear energy. Although almost every nuclear supplier state is now claiming that exporting new power reactors will strengthen nonproliferation, since it will come with the application of "enhanced" nuclear inspections, in many of the most worrisome cases, even enhanced inspections are too unreliable to effectively deter or prevent significant military diversions. As it is, international nuclear inspections are failing to maintain continuity of inspections over most of the world's spent or fresh fuel – materials that can be used as feed for nuclear enrichment and reprocessing-making plants to accelerate the production of weapons-usable materials. These nuclear fuel-making plants, moreover, can be hidden from inspectors and, even when declared, be used to make weapons-usable fuel without nuclear inspectors necessarily detecting such activity in a timely fashion.[2]

Several of these points are beginning to receive attention in the United States. The debate over these matters, though, should be broadened. Indeed, even if Washington's and the EU's favorite nuclear control initiatives (START follow-ons, a Comprehensive Nuclear Test-Ban Treaty (CTBT), Fissile Material Cut-off Treaty (FMCT), civilian nuclear fuel banks, and intrusive nuclear inspections) are all adopted and avoid running the risks noted above, the United States and its allies will still face a series of additional, major nuclear proliferation dangers.

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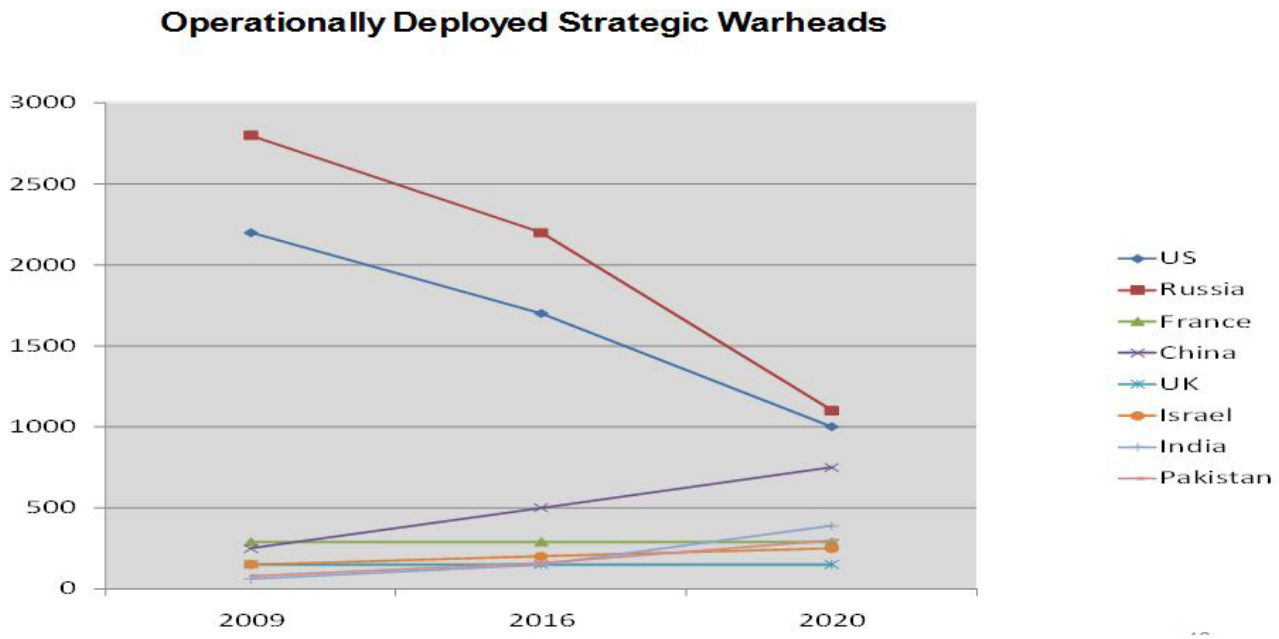
1 International Panel on Fissile Materials, *Global Fissile Materials Report 2008* (October 2008), available at http://www.ipfmlibrary.org/gfmr08.pdf [these and all subsequent urls accessed May 7, 2009]; Andrei Chang, "China's Nuclear Warhead Stockpile Rising," UPIAsia.com (April 5, 2008), available at http://www.upiasia.com/Security/2008/04/05/chinas_nuclear_warhead_stockpile_rising/7074

2 See, e.g., Henry S. Rowen, "This 'Nuclear-Free' Plan Would Effect the Opposite," *Wall Street Journal* (January 17, 2008). For additional technical background, see David Kay, "Denial and Deception Practices of WMD Proliferators: Iraq and Beyond," in *Weapons Proliferation in the 1990s*, ed. Brad Roberts (MIT Press, 1995); Victor Gilinsky, et al., "A Fresh Examination f the Proliferation Dangers of Light Water Reactors" (Washington, DC: NPEC, 2004), available at http://www.npec-web.org/Essays/20041022-GilinskyEtAl-lwr.pdf; and Andrew Leask, Russell Leslie, and John Carlson, "Safeguards As a Design Criteria – Guidance for Regulators," (Australian Safeguards and Non-proliferation Office, September 2004), available at http://www.asno.dfat.gov.au/publications/safeguards_design_criteria.pdf

A packed nuclear-armed crowd?

The first of these dangers is that as the United States and Russia incrementally reduce their nuclear weapons deployments, China, India, Pakistan, and Israel are likely to incrementally increase theirs. Currently, the United States is planning to reduce US and Russian strategic weapons deployments to as low as 1,000 warheads each. As a result, it is conceivable that in 10 years' time, the nuclear numbers separating the United States and Russia from the other nuclear weapons states might be measured in the hundreds rather than the thousands of weapons (see figure below). In such a world, relatively small changes in any state's nuclear weapons capabilities would be likely to have a much larger impact on the perceived balance of power than it does today.

Figure 1: Coming Nuclear Congestion[3]



Compounding the international volatility that this set of trends could produce are the large and growing stockpiles of nuclear weapons-usable materials (i.e., of separated plutonium and highly enriched uranium) that are being held in several states. These stockpiles already

3 Data for this chart drawn from the Natural Resources Defense Council, "Russian Nuclear Forces 2007," *Bulletin of the Atomic Scientists* (March/April 2007), available at http://thebulletin.metapress.com/content/ d41x498467712117/fulltext.pdf; Gareth Evans and Yoriko Kawaguchi, *Eliminating Nuclear Threats: A Practical Agenda for Global Policymakers (*Canberra, Australia: International Commission on Nuclear Non-proliferation and Disarmament, 2010), p. 20*;* and Robert S. Norris and Hans M. Kristensen, "U.S. Nuclear Forces, 2008," *Bulletin of the Atomic Scientists* (March/April 2008), available at http://thebulletin.metapress.com/content/ pr53n270241156n6/fulltext.pdf

exceed tens of thousands of crude bombs' worth of material in the United States and Russia and are projected to grow in Pakistan, India, China, Israel, and Japan. This will enable all of these states to increase their current nuclear deployments much more quickly and dramatically than was ever previously possible (see figures below for these states' current holdings).

Figure 2: National Stocks of Highly Enriched Uranium[4]

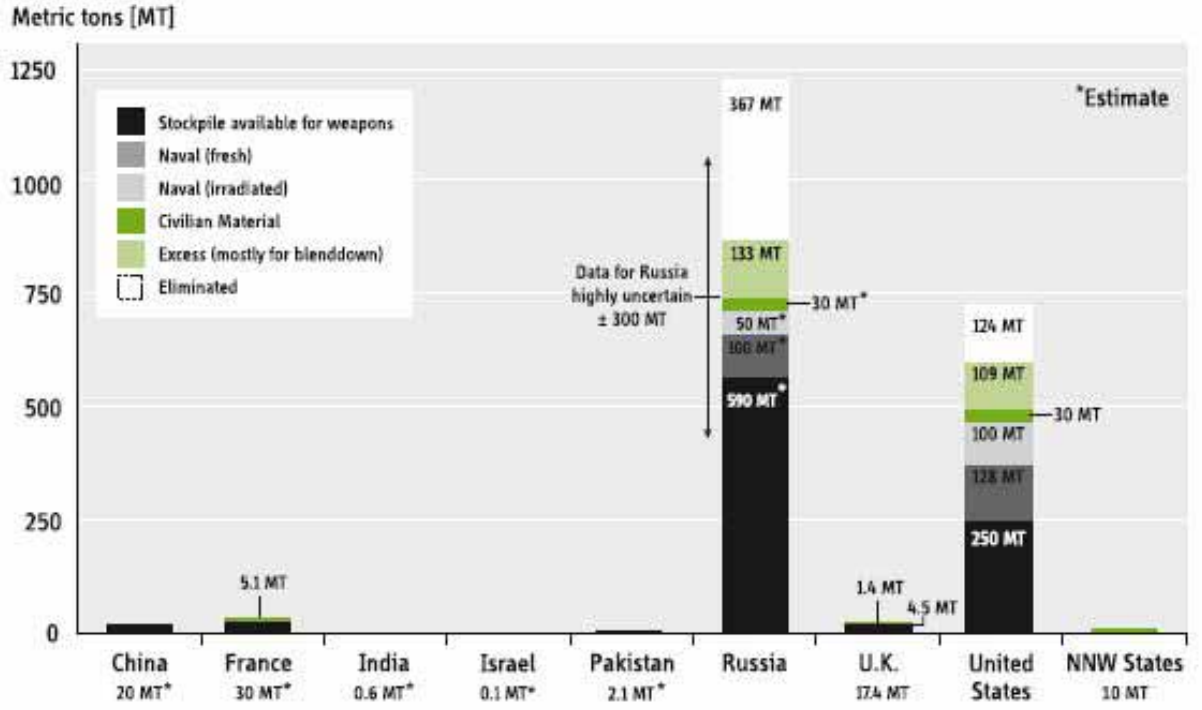


Figure 1.2. National stocks of highly enriched uranium as of mid-2009. The numbers for the United Kingdom and United States are based on their publications. The civilian HEU stocks of France, the United Kingdom are based on their public declarations to the IAEA. Numbers with asterisks are non-governmental estimates, often with large uncertainties.[22] Numbers for Russian and U.S. excess HEU are for June 2009. HEU in non-nuclear weapon (NNW) states is under IAEA safeguards. A 20% uncertainty is assumed in the figures for total stocks in China, Pakistan and Russia, and for the military stockpile in France, and 50% for India.

4 Frank Von Hippel, et al., International Panel on Fissile Material, *Global Fissile Material Report 2009*, pp. 13 and 16, available at http://www.fissilematerials.org/ipfm/site_down/gfmr09.pdf

Figure 3: National Stocks of Separated Plutonium[5]

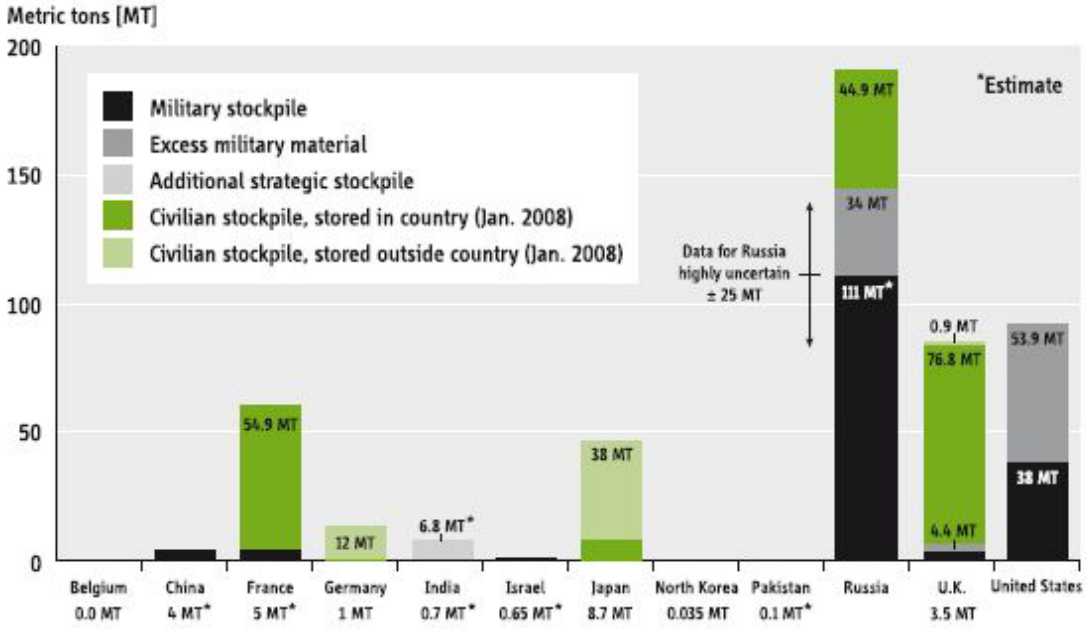


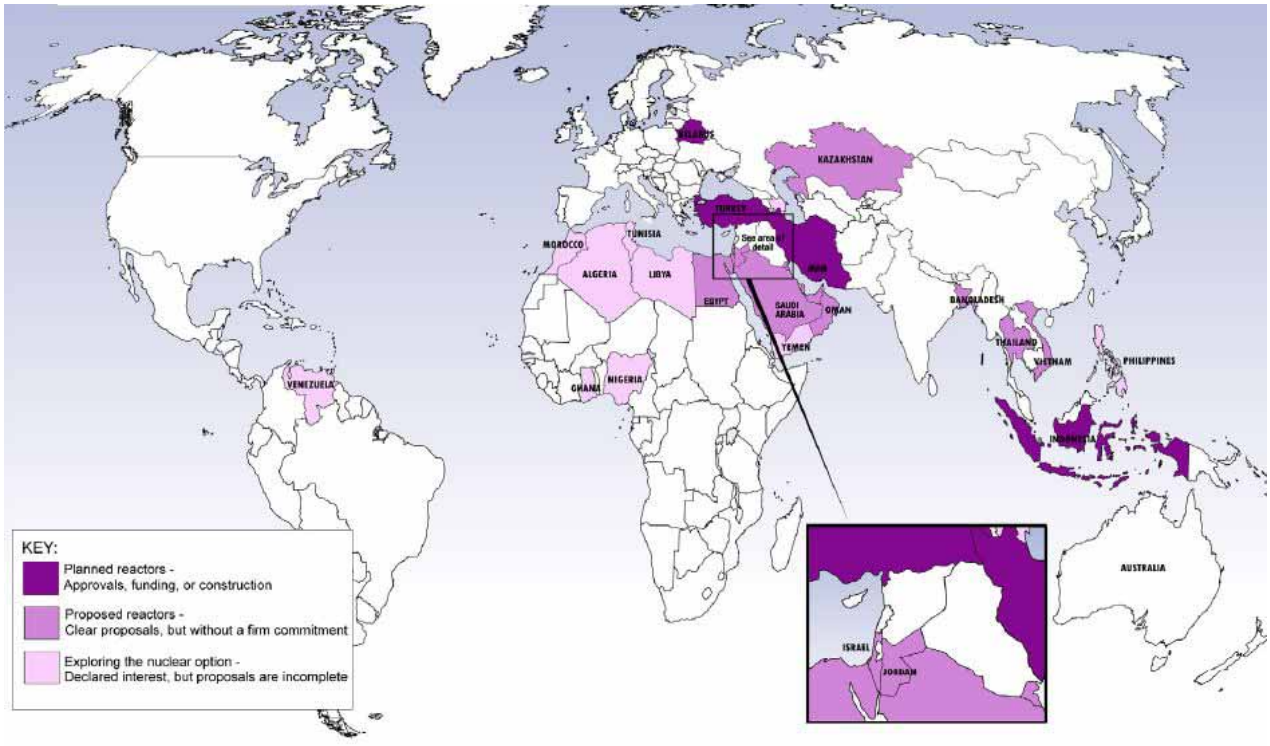
Figure 1.3. National stocks of separated plutonium. Civilian stocks are based on the most recent INFCIRC/549 declarations for January 2008 and are listed by ownership, not by current location. Weapon stocks are based on non-governmental estimates except for the United States and United Kingdom whose governments have made declarations. Uncertainties of the military stockpiles for China, France, India, Israel, Pakistan, and Russia are on the order of 20%. The plutonium India separated from spent heavy-water power-reactor fuel has been categorized by India as "strategic," and not to be placed under IAEA safeguards. Belgium holds 1.4 tons of foreign-owned plutonium, but has no stockpile of its own (Appendix 1C).

Finally, 20 years out, there could be more nuclear weapons-ready states – countries that could acquire nuclear weapons in a matter of months, like Japan and Iran. In addition, more than 25 states have announced plans to launch large civilian nuclear programs. If they all realize their dreams of bringing their first nuclear power reactors on line by 2030, it would constitute a near doubling of the 31 states that currently have such programs, most of which are in Europe (see figures below).

5 Ibid.

Figure 4: Today's States or Regions with Nuclear Reactors[6]

Figure 5: Proposed Nuclear States (2008)[7]



6 Graphs developed for NPEC by Sharon Squassoni. Available at http://www.npec-web.org/Frameset.asp?PageType=Projects

7 Ibid.

If this civilian nuclear expansion is realized, it could have major military implications. Every current weapons state first brought a large reactor on line prior to acquiring its first bomb. The United Kingdom, France, Russia, India, Pakistan, and the United States all made many of their initial bombs from reactors that also provided power to their electrical grids. The United States still uses a power reactor, a “proliferation resistant” light-water reactor operated by the Tennessee Valley Authority, to make all of its weapons-grade tritium for its nuclear arsenal.

Other plants besides large power reactors, of course, would be needed to chemically separate out weapons-usable plutonium from the spent power-reactor fuel or to enrich the uranium used to power such machines. Yet, as the recent cases of Iran and North Korea demonstrate, such fuel-making plants can be built – and in ways that can be difficult to detect – and operated to make timely detection of illicit production unlikely. Certainly, if all of the announced civilian nuclear power programs are completed as planned, the world in 2030 would be far less stable. Instead of there being several confirmed nuclear weapons states (most of which the United States can claim are either allies or strategic partners) there could be an unmanageable number of additional nuclear weapons-capable states – armed or weapons-ready (i.e., able to acquire weapons in 12 to 24 months) – to contend with, as figures 6 and 7 below depict.

Figure 6: Current Nuclear States

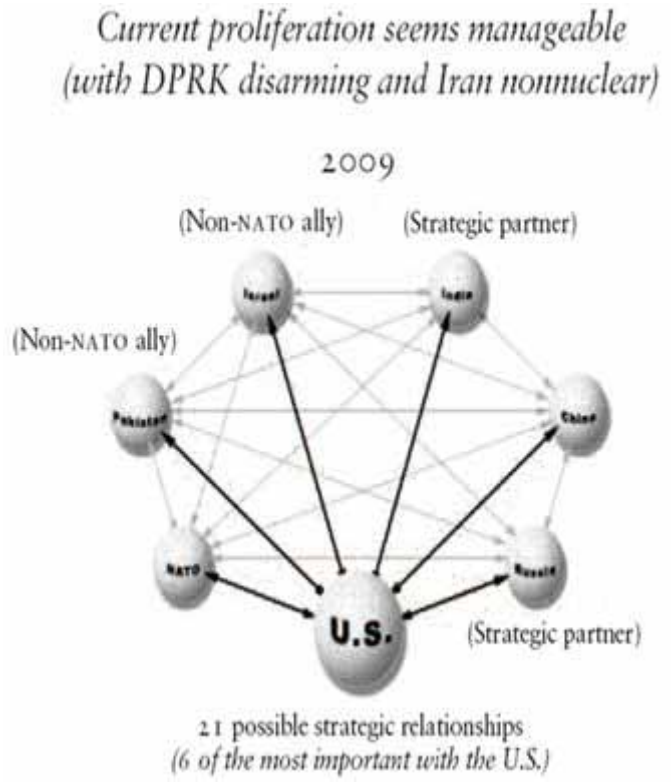
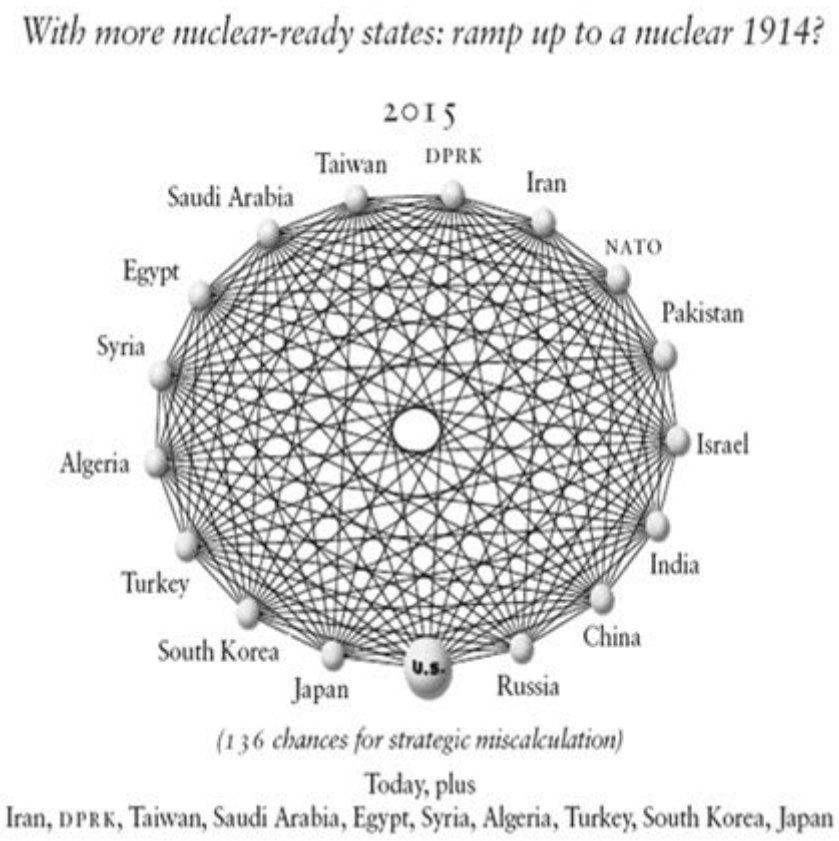


Figure 7: Nuclear-ready States by 2015



In such a world, the United States, its allies, and the EU might know who their friends and potential adversaries might be but they would have difficulty knowing what such states might do in a crisis – close ranks, go their own way developing weapons options, or follow the lead of some other nuclear-capable nation. As for possible adversaries, the United States, its allies and the EU would have difficulty determining just how lethal these adversaries' military forces might be.

Finally, these nuclear trends would surely aggravate the prospects for nuclear terrorism. Not only would there be more opportunities to seize nuclear weapons and nuclear weapons materials, there would be more military and civilian nuclear facilities to sabotage. In addition, the potential for miscalculation and nuclear war could rise to a point where even nonnuclear acts of terror could ignite larger conflicts that could turn nuclear.

This sort of international volatility is similar to that which preceded World War One and Two. These were periods in which overly ambitious arms-control objectives were pursued while states completed major covert and overt military preparations that heightened tensions and subsequently were employed in unrestricted warfare. The difference would be that over the next 20 years, the ammunition in these conflicts would not just be highly explosive, but nuclear.

Making the most of zero

All of this raises the question of whether or not we can avoid or mitigate these trends. The short answer is yes, but only if we attend more closely to several basic principles.

First, as nuclear weapons deployments decline, more care must be taken to ensure military reductions or additions actually work to decrease the chances for war.

If American and NATO nuclear security-guarantees are to continue in the immediate and mid-term to neutralize the nuclear weapons yearnings of key US allies and NATO members, it is critical that Washington and NATO avoid doing anything to undermine the correlation of forces they currently enjoy against their key nuclear competitors. In addition to making roughly equal nuclear reductions with Russia, then the United States and NATO in the near to mid-term will have to keep other nuclear-armed states, such as China and India, either from trying to catch up with the United States or – as in the case of India and China, Pakistan and India, and Japan and China – with each other.

This means that additional nuclear restraints, either in the form of nuclear weapons reductions or further limits on the production or stockpiling of weapons-usable fuels, will need to be reached not only with Russia, but with China, India, and Pakistan. As a practical matter, this also means that other nuclear weapons-ready or virtual weapons states (e.g., Israel and Japan) will have to be asked to curtail or end their production of nuclear weapons-usable materials or to dispose of some portion of what they currently have.

To date, neither the United States nor the EU have detailed how best to do this. President Barack Obama has called for the negotiation of a Fissile Material Cut-off Treaty. But most versions of this agreement allow "civilian" nuclear fuel production, which is virtually identical to military fuel production. Also, after decades of fruitless negotiations in Geneva, it is unclear if any such agreement could ever be brought into force. Negotiations are currently being held up by the Pakistanis.

There are, however, ways to restrain fissile production outside of negotiating an FMCT. Specifically, some officials, including those advising Secretary of State Hillary Clinton, have suggested a complementary approach known as the Fissile Material Control Initiative. Instead of a binding treaty, both NPT weapons states *and* nonweapons states would simply identify what portion of their separated plutonium and highly enriched uranium stocks were in excess of either their military *or* civilian requirements and secure or dispose of them.[8] One could also make it more difficult for states to access the surpluses they declare by requiring the prior consent of all parties participating in the initiative for access to be granted.[9]

Yet another practical idea, which would have direct bearing on India's nuclear weapons activities, would be to ensure that the implementation of the US civilian nuclear cooperative agreement with New Delhi does nothing to help India make more nuclear weapons-usable fuels than India was producing when the deal was finalized late in 2008. Under the NPT, the states that had nuclear weapons in 1967 – the United States, Russia, France, the United Kingdom, and China – swore not to ever help any other state to acquire them directly or indirectly. Meanwhile, under the Hyde Act, which authorized the civilian US-Indian nuclear deal, the White House is routinely required to report to Congress on just how much uranium

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8 See, e.g., Robert Einhorn, "Controlling Fissile Materials and Ending Nuclear Testing," presentation before the International Conference on Nuclear Disarmament, Oslo (February 26–27, 2008), available at http://www.ctbto.org/fileadmin/user_upload/pdf/External_Reports/paper-einhorn.pdf

9 See Albert Wohlstetter, "Nuclear Triggers and Safety Catches," in *Nuclear Heuristics: Selected Writings of Albert and Roberta Wohlstetter*, eds. Robert Zarate and Henry Sokolski (Carlisle, PA: US Army War College Strategic Studies Institute, 2009)

fuel India is importing, how much it is using to run its civilian reactors, how much uranium it is producing domestically, and the extent to which the operation of its unsafeguarded reactors is expanding its stockpiles of unsafeguarded plutonium with either the direct or indirect help of NPT weapons states.[10]

If India's unsafeguarded plutonium stockpiles grow faster per year than was the case prior to the nuclear cooperative agreement's finalization in 2008, and it can be shown to be related to Indian uranium imports from one or more of the NPT weapons states, the later would be implicated in violating Article I of the NPT. To prevent such a violation or, at least, limit the harm it might do, the United States should alert all other nuclear-supplying states and ask that they suspend civilian nuclear assistance until India's unsafeguarded nuclear weapons-usable material production declines. Here, the logical place to make this request would be the Nuclear Suppliers Group. Such vigilance should also be matched with efforts to keep Pakistan from expanding its nuclear weapons capabilities as well.

As for trying to maintain the relative parity in the forces of competing nuclear-armed states through nonnuclear military assistance or buildups, the challenge will be to substitute conventional arms for nuclear ones in a manner that avoids increasing one or both side's interests in acquiring more nuclear weapons. Unfortunately, simply deploying more advanced nonnuclear systems to compensate for forgone nuclear systems will not necessarily assure this.

Consider long-range precision strike- and advanced command control and intelligence systems in the case of India and Pakistan. Pakistan believes it must threaten to use its nuclear weapons first to deter India's superior conventional forces. Precision strike systems, however, could conceivably target Pakistan's nuclear weapons. As a result, one could imagine that arming India with such weapons would only put Pakistan on an even higher nuclear alert and encourage Islamabad to acquire even more nuclear weapons to assure that their nuclear forces could not be knocked out by precise Indian conventional strikes. Exporting the wrong kinds of advanced nonnuclear weapons systems in India or helping it to build them in disproportionate numbers could adversely influence Pakistan's nuclear weapons plans.

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10 See the Henry J. Hyde United States-India Peaceful Atomic Energy Cooperation Act of 2006, *Implementation and Compliance Report*, available at http://frwebgate.access.gpo.gov/cgi bin/ getdoc.cgi?dbname=109_cong_bills&docid=f:h5682enr.txt.pdf

Ballistic missile defenses could also be tricky. Under the right circumstances, having such defenses could afford a nonnuclear form of deterrence that might facilitate reducing the numbers of deployed nuclear weapons. Instead of "neutralizing" a possible opponent's missiles by targeting them with nuclear or nonnuclear offensive weapons, active missile defenses might be used to counter them after launch. They also could be useful as a form of insurance against cheating on any future nuclear-capable ballistic missile reduction agreements. As already noted, to secure these benefits, more than their mere deployment may be necessary.

Again, consider the Indian and Pakistani case. While Pakistan insists it must use its nuclear weapons first in any major war against India, New Delhi is hoping to use its conventional forces to capture enough of Pakistan from a "cold start" to get Islamabad to quickly sue for peace. India has also begun to develop missile defense systems of its own to counter both Pakistani and Chinese offensive missile threats.

Under these circumstances, having equal amounts of missile defenses between India and Pakistan would only give India yet another nonnuclear military edge against Islamabad. This, in turn, risks encouraging Pakistan to beef up its offensive nuclear missile forces even more. The only way to counter this and help to secure the benefits of missile defense for both countries would be to address the underlying conventional asymmetry between them.

One reason regional security experts have long favored creating low, medium, and high conventional deployment zones on both sides of the Indo-Pakistani border is to equalize each side's ability to launch "quick" conventional attacks against one another. A key element of these proposals is that both sides eliminate their existing short-range ballistic missiles, since their use could mistakenly prompt nuclear reactions. If such military confidence-building measures were implemented, they might be effective enough to attenuate the perceived stability risks of deploying more advanced, discriminate, nonnuclear military systems.[11]

Elsewhere, other measures might be required. As China increases its nuclear and nonnuclear missile superiority over Taiwan and its capability to target US carrier battle groups with advanced, conventional ballistic missiles, the United States and its Pacific allies must worry that Beijing may be able to overwhelm the missile defenses they are now working on. China,

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11 On these points, see Peter Lavoy, "Islamabad's Nuclear Posture: Its Premises and Implementation," in *Pakistan's Nuclear Future: Worries beyond War*, ed. Henry Sokolski (Carlisle, PA: Strategic Studies Institute, 2008), pp. 129–66; see also General Feroz Khan, "Reducing the Risk of Nuclear War in South Asia," September 15, 2008, available at http://www.npec-web.org/Essays/20090813-khan%20final.pdf

meanwhile, is developing ballistic missile defenses of its own to counter possible US nuclear and precise conventional intercontinental ballistic missile attacks. Countering offensive Russian ballistic missiles may also be a Chinese concern. All of these missile worries suggest that diplomatic efforts might usefully be focused on reaching offensive ballistic missile limits in Asia to assure that whatever missile defenses are deployed there will not immediately be overwhelmed.

Here, several precedents exist. START, which limits US and Russian strategic ballistic missile delivery systems, is one. The Intermediate Nuclear Forces Treaty, which covers Russian and NATO missiles with ranges between 500 and 5,500 kilometers, is another. The Missile Technology Control Regime (MTCR), which limits commerce in missiles capable of lifting 500-kilogram payloads at least 300 kilometers in range, is another still.

The trick in reaching new additional ballistic missile limits is to make sure they are aggressive enough to capture the ballistic missiles that matter so as to reduce the need or desire to deploy more nuclear warheads without creating new categories of permissible missiles. It certainly would make little sense to eliminate ballistic missiles above 500 kilometers range only to end up legitimizing slightly lower-range missile systems that are above the limits restricted by the MTCR.

Yet another related concern in limiting offensive ballistic missiles while cutting out a space for the deployment of missile defense systems that employ ballistic missile technology themselves is to make sure the proliferation of missile defenses does not itself result in the further spread of large ballistic missiles or related technology. Here, one might start by prohibiting the export of ballistic missile-based defensive systems that employ rockets in excess of the MTCR's category-one missile limits (i.e., on missiles capable of lifting 500 kilograms more than 300 kilometers). Alternatively, agreements might be reached to encourage states to move away from the employment of missile defense systems that rely on large ballistic missile systems toward alternatives (e.g., drone-based boost phase, space, and directed energy-based systems).

This brings us to the second general principle.

Reducing existing nuclear weapons and nuclear-capable delivery systems should be related more closely to preventing their further spread to additional states.

Currently, the connection between reducing nuclear arms and preventing their spread is mostly symbolic. As the US and Russia reduce their nuclear deployments, other nuclear-

armed states, it is argued, ought follow and this, in turn, should persuade nonnuclear weapons states to submit to much more intrusive inspections of their civilian nuclear activities.[12] Putting aside the hard cases of Iran and North Korea, this line of reasoning, however, ignores several key technical developments and turns on several questionable political assumptions.

First, after the International Atomic Energy Agency (IAEA) failed to detect the covert nuclear programs in Iraq, Iran, Syria, and North Korea, it is an open question of whether "enhanced" international nuclear inspections will ever be able to reliably detect future illicit nuclear activities. This is especially so if, as some believe, large civilian nuclear programs spread in regions like the Middle East.

Second, not only the United States but Israel, Japan, NATO, India, Russia, and China are planning to deploy ballistic missile defense systems – each for very different reasons. Yet, US and allied approaches to controlling nuclear strategic threats has been practically silent as to whether these defense programs should be promoted or restricted and, if so, how. Nor has there been, outside of strategic reduction talks with Russia, much discussion as to whether or how other states' development of ballistic missiles (both nuclear and nonnuclear) should be approached.

Then there are political questions. How likely is it that Russia will agree to further nuclear cuts beyond the current START negotiations? Will there be yet another START agreement to lower numbers to 1,000 strategic deployed warheads? Will Russia agree to limit its non-strategic nuclear weapons? What demands will Moscow make for such reductions? Will Russia demand the United States and NATO cripple their conventional and missile defense plans? Finally, when, if ever, might such agreements be reached? The success of America's and the EU's arms control and non-proliferation policies depend on the answers to these questions being favorable to the United States.

Related to the political issues noted above is the questions of enforcement. If there are no new penalties or risks for developing nuclear weapons-related capabilities, how likely is it that states without nuclear-capable missiles or atomic weapons will keep clear of trying to acquire them? Certainly, the greater Middle East is watching what, if anything, the United States and its allies might do to penalize Iran's nuclear misbehavior. Most states in the region

12 See, e.g., Gareth Evans and Yoriko Kawaguchi, *Eliminating Nuclear Threats: A Practical Agenda for Global Policymakers* (Canberra, Australia: International Commission on Nuclear Non-proliferation and Disarmament, 2010), pp. 3–36.

are already hedging their nuclear bets by acquiring “peaceful” nuclear programs of their own. Similar dynamics are in play in the Far East in relation to North Korea’s nuclear weapons program. Beyond these two cases, there is the general worry that the enforcement of nuclear nonproliferation-limits lack any teeth. What, if anything, will be done to prevent further nonproliferation violations?

These many questions all suggest the need for an additional set of arms control and nonproliferation measures to complement the set of arms control measures that the United States and the EU are currently pushing. Why not complement these efforts (which may or may not succeed) by promoting more immediate, incremental limits?

Here, it would be most useful to link efforts to constrain existing nuclear arsenals with preventing their further spread and to link both to efforts of reducing and constraining nuclear-capable ballistic missiles. Several initiatives here would qualify. Instead of waiting for Iran, Pakistan, India, North Korea, and Egypt to ratify the CTBT, why not use the implicit ban on nuclear testing contained in the NPT to secure an immediate agreement among civilian nuclear supplier states to block nuclear trade with any NPT nonweapons state that tests? Once agreement on this has been reached, an additional agreement might be sought to expand such trade restrictions to nuclear weapons states as well.

Why not proceed with the Fissile Material Control Initiative, which would have an immediate (albeit initially modest) impact both on nuclear weapons states and nonweapons states, while pushing the FMCT, which would only affect nuclear weapons countries?

Currently, violators of the NPT and IAEA safeguards and states that withdraw from the NPT while still in violation are not prohibited from receiving nuclear-capable missile technology and assistance from missile technology-supplying states. Why not eliminate this loophole with the adoption of an automatic cutoff to goods controlled by the MTCR to these nuclear violators?

States that flaunt the nuclear rules, such as North Korea, are also free to test nuclear-capable missiles outside of their borders. Under current international law, all of this is legal. Yet, such missiles are ideal for carrying nuclear warheads and their development and testing are inherently destabilizing. Should there not be an international norm – as there is with piracy and slave trading – giving states the technical power to shoot such objects out of international air space (e.g., the United States, Russia, Israel, and soon Japan, NATO, and China) as with “outlaw” objects? If progress is made on creating additional limits on ballistic missile

deployments (e.g., a global Intermediate Nuclear Forces Treaty), should violators of these understandings not also be banned from receiving controlled missile and controlled nuclear goods and be subject to similar missile testing restrictions?

Of course, nuclear proliferation to additional states will continue so long as nuclear inspections are seen as a solution to preventing such spread when, in many important cases, they cannot be relied upon. To do better, a third principle will need to be applied.

International nuclear inspectors should be encouraged to distinguish between nuclear activities and materials that they can reliably safeguard against being diverted to make bombs and those that they cannot.

The NPT is clear that all peaceful nuclear activities and materials must be safeguarded — that is, inspected in a manner that can reliably prevent them from being diverted to make nuclear weapons. Most NPT states have fallen into the habit of thinking that if they merely declare their nuclear holdings and allow international inspections, they have met this requirement.

This is dangerously mistaken. After the nuclear inspection gaffes in Iraq, Iran, Syria, and North Korea, we now know that the IAEA cannot reliably detect covert nuclear activities early enough to allow others to intervene to prevent possible bomb-making. We also now know that inspectors annually lose track of many bombs' worth of nuclear weapons-usable plutonium and uranium at declared nuclear fuel-making plants. Privately, IAEA officials admit that the agency cannot assure continuity of inspections for spent- and fresh fuel rods at more than half of the sites that it inspects. Finally, we know that declared plutonium and enriched uranium can be made into bombs and their related production plants diverted so quickly (in some cases, within hours or days) that no inspection system can offer timely warning of a bomb-making effort. Yet, any true safeguard against military nuclear diversions must reliably detect them early enough to allow outside powers to intervene to block a bomb from being built. Anything less is only monitoring that might, at best, detect military diversions *after* they occur.

In light of these points, it would be useful for the IAEA to concede that it cannot safeguard all that it inspects against possible military diversions. This would finally raise first-order questions about the advisability of producing or stockpiling plutonium, highly enriched uranium, plutonium-based reactor fuels, and believing that these materials and activities can be safeguarded. At the very least, it would suggest that nonweapons states ought not to

acquire these materials or facilities beyond what they already have. These points are important enough to raise before, during, and *after* the May 2010 NPT Review Conference.

In this regard, the United States and other like-minded nations might independently assess whether or not the IAEA can meet its own inspection goals; under what circumstances (if any) these goals can be met; and, finally, whether these goals are high enough. The US House of Representatives last year approved legislation to require the executive to make such assessments routinely and to report their findings. Similar legislation has been proposed in the Senate.[13]

Finally, to assure safe, economically competitive forms of clean energy, greater attention should be paid to comparing costs and discouraging the use of government financial incentives for commercialization projects, especially nuclear power.

Supporters of nuclear power insist that its expansion is critical to prevent global warming. Yet, they generally downplay or ignore the nuclear weapons proliferation risks associated with this technology's further spread. That said, it may be impossible to prevent the spread of nuclear power if it turns out to be a cheap and convenient way to provide low-carbon energy. Given the security premium associated with the further spread of nuclear power technologies, though, no government should pay extra to promote it and no government should support other governments doing so.[14]

Certainly, creating new, additional government financial incentives specifically geared toward building more commercial nuclear plants and their associated fuel-making facilities will only increase the difficulty of accurately comparing it with nonnuclear alternatives. Not only do such subsidies mask nuclear power's true costs, they tilt the market against less subsidized, potentially sounder alternatives. This is troubling since nuclear power continues to enjoy massive government support and the most dangerous forms of civilian nuclear energy – nuclear fuel-making in most nonweapons states and large power reactor projects in war-torn regions like the Middle East – turn out to be poor investments as compared to much safer alternatives.[15]

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13 See Section 416 of the House State Authorization Act of 2010 and 2011 "Implementation of Recommendations of Commission on the Prevention of WMD Proliferation and Terrorism," available at http://www.govtrack.us/congress/billtext.xpd?bill=h111-2410

14 As the re-launch of German export credits ("Hermes") for nuclear power generation in Brazil, Russia, and China or President Sarkozy's proposals to finance nuclear power with development funds and loans.

15 See, e.g., Peter Tynan and John Stephenson, "Nuclear Power in Saudi Arabia, Egypt, and Turkey – how cost effective?" February 9, 2009, available at http://www.npec-web.org/Frameset.asp?PageType=

There are several ways to avoid this. The first would be to get as many governments as possible to open up all large civilian energy projects in their countries to international competitive bidding. This is already done in a number of countries. The problem is that when states want to build large civilian nuclear reactors, they limit the competition to nuclear bids rather than open the competition to any energy option that could meet a given set of environmental and economic criteria. Limiting the competition in this way ought to be discouraged internationally.

Most advanced nations, including the United States, claim to back the principles of the Energy Charter Treaty and the Global Charter on Sustainable Energy Development. These international agreements are designed to encourage all states to open their energy sectors to international bidding to assure that all energy options are considered and that as many subsidies and externalities associated with each are internalized and reflected in the price of what is being proposed. Promoting adherence to these rules is essential if the United States and other states are serious about reducing carbon emissions in the quickest, least costly manner.

Here, one might reference and enforce the principles of the Energy Charter Treaty and the Global Charter on Sustainable Energy as a part of any follow-on to the understandings reached at Kyoto and Copenhagen. In addition, states that choose to build a nuclear plant when less-costly nonnuclear alternatives would clearly make more sense ought to be flagged by an economic competitiveness monitoring body (e.g., the World Trade Organization) that might assume responsibility for overseeing large international energy project transactions. Finally, such uneconomic nuclear picks (e.g., several proposed Middle Eastern nuclear projects) might also be referred to the IAEA for further investigation regarding the project's true purpose.[16]

Single&PDFFile= Dalberg-Middle%20East-carbon&PDFFolder=Essays; "Frank von Hippel, "Why Reprocessing Persists in Some Countries and Not in Others: The Costs and Benefits of Reprocessing," April 9, 2009, available at http://www.npec-web.org/Frameset.asp?PageType=Single&PDFFile= vonhippel%20%20TheCostsandBenefits&PDFFolder=Essays; Doug Koplow, "Nuclear Power as Taxpayer Patronage: A Case Study of Subsidies to Calvert Cliffs Unit 3," available at http://www.npec-web.org/Frameset.asp?PageType=Single&PDFFile=Koplow%20-%20CalvertCliffs3&PDFFolder=Essays

16 For more on these points, see Henry Sokolski, "Market Fortified Non-proliferation," in *Breaking the Nuclear Impasse* (New York, NY: The Century Foundation, 2007), pp. 81–143, available at http://nationalsecurity.oversight.house.gov/documents/20070627150329.pdf. For more on the current membership and investment and trade principles of the Energy Charter Treaty and the Global Energy Charter for Sustainable Development, go to http://www.encharter.org and http://www.cmdc.net/echarter.html

As a complementary effort, the world's advanced states could also work with developing countries to create nonnuclear alternatives to address their energy and environmental needs. In the case of the United States, this would entail implementing existing law. Title V of the Nuclear Nonproliferation Act of 1978 requires the executive branch to do analyses of key countries' energy needs and identify how these needs might be addressed with non-fossil, nonnuclear energy sources. Title V also calls on the executive branch to create an alternative energy cadre to help developing nations explore these alternative options. To date, no US president has chosen to implement this law. The US Congress has indicated that it would like to change this by requiring Title V country energy analyses (and outside, nongovernmental assessments of these analyses) to be done as a precondition for the US initialing of any new, additional US nuclear cooperative agreements.[17] The United Nations, meanwhile, has an alternative, renewable (nonnuclear) energy initiative of its own aimed at assisting developing states. As with most of the other suggestions already made, the United States and other states can emphasize these initiatives without waiting for any international treaty agreement.

Conclusion

With states' growing concerns about energy security and reducing carbon emissions, governments have again gravitated toward supporting the expansion of civilian nuclear power. The United States, France, Russia, China, Japan, South Korea, India, Pakistan, Brazil, and a host of other developing states in the Middle East and Asia are now planning on exporting or buying power-reactor programs using state funds and financing.

Yet, in all this, far too little attention has been paid to how one can increase the amount of large reactor programs without also spreading the means to make nuclear weapons. Technically, what is required to boil water with nuclear energy is virtually identical to the means required to make scores of bombs' worth of weapons-usable plutonium.

As a practical matter, one cannot train the hundreds of engineers and technicians required to build and operate such programs without running the risk that they might also learn how to make the fuel necessary by recycling their spent fuel. Nor is it possible to verify effectively the pledges that states might make to forswear making nuclear fuel. Not only has the IAEA

17 See Letter from Members of Congress Brad Sherman, Edward Markey, and Ileana Ros-Lehtinen to Secretary of State Hillary Clinton April 6, 2009 available at http://bradsherman.house.gov/pdf/NuclearCooperationPresObama040609.pdf

failed in the past to find covert nuclear fuel-making plants, but it has repeatedly discovered that it missed accounting for many bombs' worth of separated plutonium and enriched uranium well after it was produced. No proposed system of inspections, including the additional protocol, sufficiently addresses these problems. As a result, unless one is convinced that a state is out of the bomb-making business, transferring to it the means to conduct a large nuclear reactor program runs the significant risk of nuclear weapons proliferation.

If it was clear that states had no choice but to acquire large nuclear reactors to meet their energy security or scientific research demands while reducing their carbon footprints, one would have to be resigned to these risks. Ever more states would become nuclear weapons-ready and instead of moving closer to zero nuclear weapons and reducing the threats of nuclear use, the world would drift ever closer to realizing them.

Fortunately, there are several plausible, clean, economically competitive nonnuclear energy options and nuclear threat-reduction measures beyond those being currently promoted that offer hope that we can avoid this civilian-military nuclear dilemma. New discoveries of natural gas are making this relatively clean and inexpensive fuel a possible bridge to more complicated, and currently more expensive, alternative energy options. The costs of these nonnuclear alternatives, moreover, are dropping. Finally, energy efficiencies, new modes of electrical storage, and distribution systems promise significant reductions in the amount of energy required to produce a given unit of gross domestic product.

The key trick in promoting these nonnuclear energy options over nuclear power will be to compete them economically in open bidding for all large energy projects internationally. Instead of holding competitions for specific energy programs – for example, calling for international bids for a nuclear power plant or a carbon sequestration program – states should be encouraged to hold competitions that only specify the amount of power needed and the environmental requirements that must be met. What we are interested in is promoting the quickest, least costly (assuming the costs of government subsidies, a range of possible prices on carbon, etc., are internalized) way to meet the stated requirements.

Finally, it is imperative that the states most concerned about reducing existing nuclear threats complement their existing list of formal treaty efforts – which may take years, if ever, to be realized – with more practical steps that can be taken now. Among these are encouraging states to reduce their production of weapons-usable fissile materials for civilian or military

purposes by getting them to announce that some amount of their existing holdings is in excess of their civilian or military requirements and then getting them to dispose of this material or make it far more difficult to access. Also, more should be done to assure civilian nuclear fuel sales to non-NPT states, such as India, so that they do not end up fueling nuclear competitions like the one between Pakistan and India.

Nuclear supplier states should also encourage greater candor about the shortcomings of the IAEA nuclear safeguards system and help in clarifying that which nuclear inspections cannot be expected to detect reliably. Finally, it is imperative that greater care be taken regarding the deployment of nonnuclear systems to reduce states' interests in acquiring or relying on nuclear ones. Here, more should be done to limit offensive, nuclear-capable ballistic missiles.

The advantage of these recommendations is that they can be acted upon now. On the other hand, there are no deadlines for their implementation. In these matters, as with any important problem set, all that is required is to begin.

Glossary and list of abbreviations

BWR	Boiling water reactor
CCGT	Combined cycle gas turbine
CEGB	Central Electricity Generating Board
COL	Construction and Operating License
CTBT	Comprehensive Nuclear Test-Ban Treaty
DOE	US Department of Energy
EIA	Energy Information Administration
EPACT	Energy Policy Act
FBR	Fast breeder reactor
GCR	Gas-cooled reactor
GDA	Generic Design Assessment program
HWR	Heavy water reactor (including Candu)
IAEA	International Atomic Energy Agency
IDC	Interest during construction
MTCR	Missile Technology Control Regime
NII	Nuclear Installations Inspectorate
NINA	Nuclear Innovation North America
NPT	Nuclear Nonproliferation Treaty
NRC	US Nuclear Regulatory Commission
O&M	Operations and maintenance
Overnight cost	The construction cost of a nuclear plant including the cost of the first fuel load but excluding any financing charges
PIU	Performance and Innovation Unit
PWR	Pressurized water reactor
RBMK	(Russian reactor design using graphite and water)
START	Strategic Arms Reduction Treaty
Turnkey	A fixed price contract covering the design and construction of the entire plant
WWER	Russian PWR